FRD Activities Report
April 2001

Research Programs

GAUNTLET (AFTAC) Project

The field deployment of GAUNTLET was begun and completed during April. Personnel first arrived in Dugway, Utah, at the West Desert Test Center on 02 April and stayed four weeks. Up to nine staff were simultaneously deployed. FRD's contribution to the experiment consisted of the atmospheric release, detection, and analysis of sulfur hexafluoride (SF_6). The experiment supported the NOAA program objective to improve the understanding of atmospheric processes with the specific goal of developing and enhancing local wind-field prediction capabilities.

A total of seven tracer tests were completed. Each SF_6 release, always from a 21-m stack, lasted four hours. Three tests were conducted during daylight hours, while four were nocturnal tests. Three mobile SF_6 analysis systems installed in SUV's were placed on three arcs, ranging in distance up to 90 km from the release point. Tracking of the SF_6 plume continued up to six hours after the release had ended. Figure 1 shows the mobile SF_6 data acquired from Test 5, a nocturnal test conducted 17-18 April. Each data point indicates the location and concentration of the center of the SF_6 plume for each pass of the analyzer through the plume. The time of measurement is also noted.

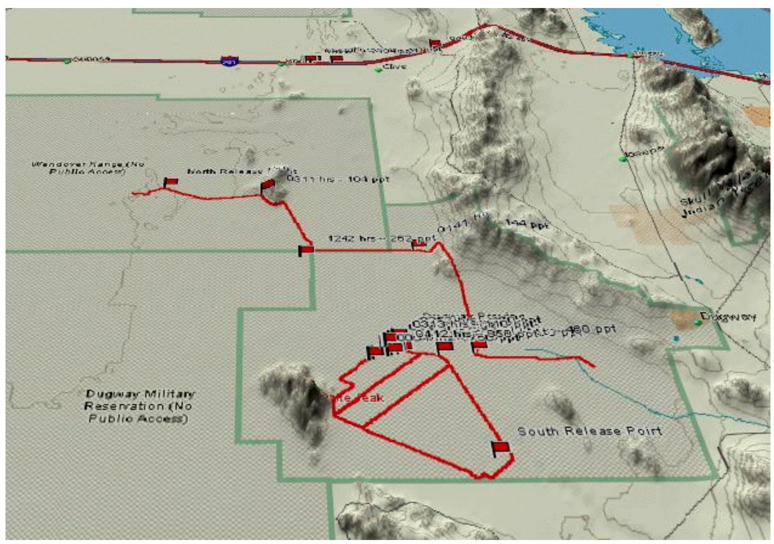

Figure 1. Location and peak concentration of the Test 5 (17-18 April) SF_6 plume, as determined by mobile SF_6 analyzers passing quasi-perpendicular through the plume. Boundary of Dugway Proving Ground, surrounding terrain, and Interstate 80 (top of image) are also indicated.

For this experiment we utilized the internet extensively. At the conclusion of each test, the data from the mobile analyzers were gathered and sent via FTP to the FRD server. Each of the operator's log books were scanned, saved as GIF files, and also sent to the server. The data were analyzed at FRD within 24 hours using new quality control procedures. Instrument problems were quickly noted and repaired before the succeeding test began, enabling us to greatly improve our field operation. We were able to discover and fix problems while still in the field, instead of discovering them after we returned home. (Kirk.Clawson@noaa.gov, and staff)

WAPEX

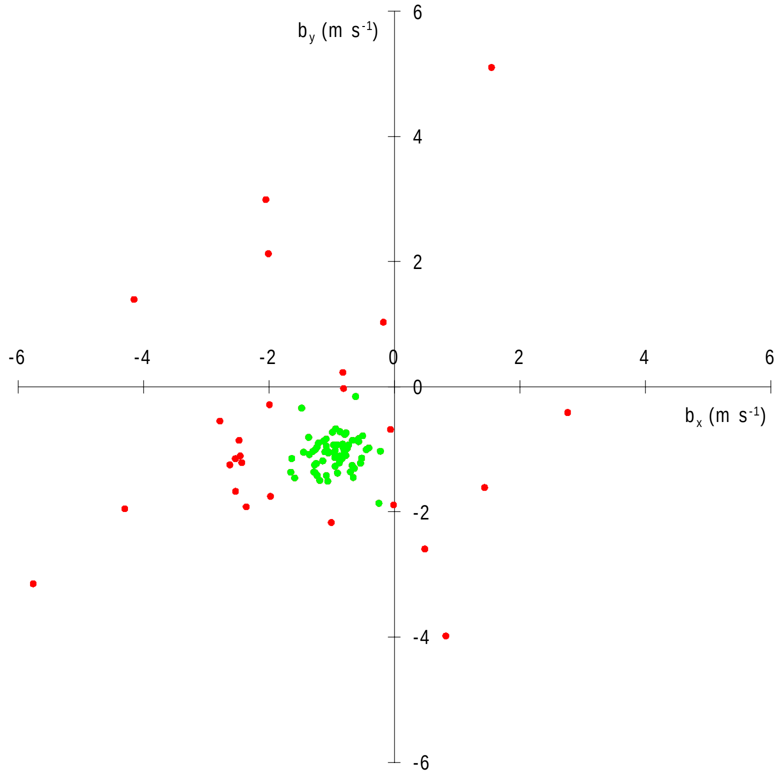

Figure 2. Scatter plot of longitudinal (b_x) and lateral (b_y) biases from 94 low-level flight legs over 19 flights acquired by the LongEZ during WAPEX. Green data points represent values used to determine the consensus average of b_x and b_y while the red points represent outliers.

Wind vector estimates obtained from aircraft are often subject to several error sources because of the complex nature of measuring the parameters from which the vector is derived. Errors may be random or systematic (i.e., bias). Over the long-term, random errors usually average towards zero; however, these uncertainties add unwanted variance to wind measurements. Systematic errors, on the other hand, can affect the mean wind vector both in magnitude and direction. A number of calibration coefficients are used in the determination of the mean wind based on probe geometry and aircraft attitude. These constants include temperature recovery factor (R_t), angle of attack constants (K_α and K_β), upwash factor (K_{up}), zero lift offset (α_0), adjustment to dynamic pressure (ϵ_q), and pitch, roll, and heading offsets. A small error in one or more of these constants can result in a significant bias in the mean wind vector.

The horizontal wind vector is simply the difference between vector representing the aircraft motion relative to the Earth and the vector of the aircraft motion relative to the air. A simple procedure (Grossman, R. L., 1977: A procedure for the correction of biases in winds measured from aircraft. *J. Appl. Meteor.*, **16**, 654-658.) has been adapted to determine the bias in the motion along the aircraft longitudinal axis (b_x) and along the aircraft lateral axis (b_y). These biases are determined using the following simple trigonometric formulas:

$$b_x = \frac{\Delta v\,(\cos\theta_1 - \cos\theta_2) + \Delta u\,(\sin\theta_1 - \sin\theta_2)}{(\cos\theta_1 - \cos\theta_2)^2 + (\sin\theta_1 - \sin\theta_2)^2}$$

$$b_y = \frac{\Delta v\,(\sin\theta_1 - \sin\theta_2) - \Delta u\,(\cos\theta_1 - \cos\theta_2)}{(\cos\theta_1 - \cos\theta_2)^2 + (\sin\theta_1 - \sin\theta_2)^2}$$

where θ_1 and θ_2 is the true heading for two distinct aircraft flight legs, and Δu and Δv are the measured wind components ($\Delta u = u_1 - u_2$ and $\Delta v = v_1 - v_2$). It is important to note that changes in the wind vector in time and space make estimates of b_x and b_y invalid. However, during most of the WAPEX flights, winds were relatively constant over the flight domain. A total of 94 low-level flux legs from 19 different flights were used to determine the longitudinal and lateral biases (Figure 2). Most of the data points are clustered in one quadrant which is a very good indication that the discrepancies in measured winds exhibit a consistent bias. Using a simple consensus averaging technique (similar to that used for ground-based radar wind profilers), a mean value for b_x and b_y was found to be -0.944 and -1.057 m s^{-1}, respectively. This consensus average used 68 individual values of b_x and b_y. Thus, about one in four data points were discarded from the consensus average.

Using the following equations, the corrected wind vectors are simply:

$$u_c = u_m - b_x \sin\theta + b_y \cos\theta$$

$$v_c = v_m - b_x \cos\theta - b_y \sin\theta$$

where u_m and v_m are the original measured component wind velocities.

Figure 3 is a polar scatter plot of wind speed and direction before and after application of the Grossman technique for WAPEX flights 7, 8, and 12. Large discrepancies in wind speed and wind direction are seen in the original data. For example in Flight 7, wind speed and wind direction varied from 2 to over 5 m s^{-1} and from 285 to 330 deg, respectively. After applying the biases corrections, range of wind speed and wind direction was reduced to 3.5 to 4.5 m s^{-1} and 300 to 315 deg, respectively. Similar improvements are also seen in all WAPEX flights. These corrections are being made to the WAPEX winds so that turbulent parameters such as the drag coefficient (C_D),

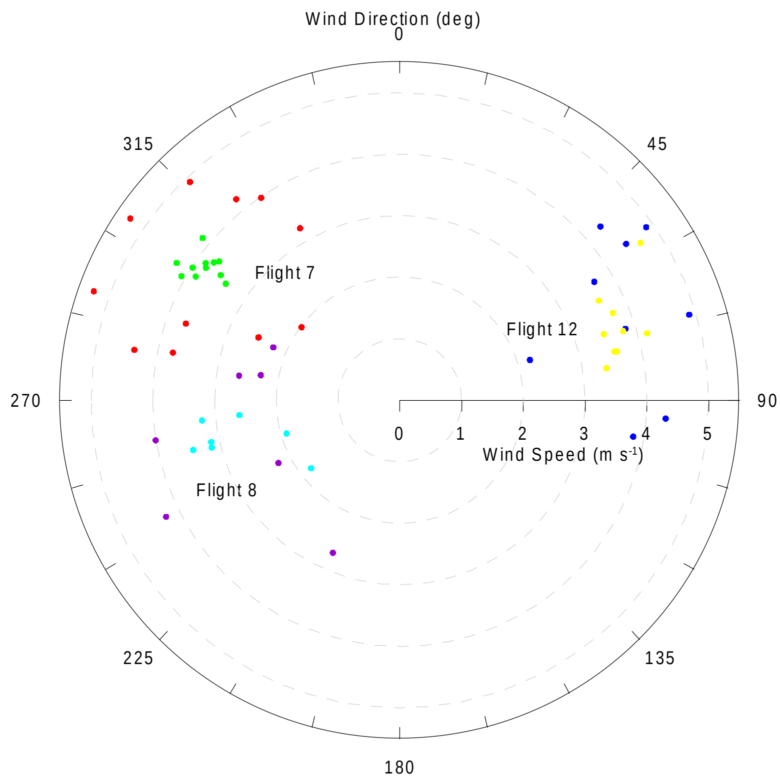

Figure 3. Polar scatter plot of wind speed and direction before (red, purple, blue) and after (green, cyan, yellow) for WAPEX flights 7, 8, and 12.

friction velocity (u_*), and roughness length (z_o) can be related as functions of mean wind velocity. (Jerry.Crescenti@noaa.gov, Jeff French, and Tim Crawford)

CBLAST-Low

Work continues on upgrading the data acquisition system hardware and software used on the LongEZ.

A cooperative effort between FRD and Andrew T. Jessup of the University of Washington is being forged for the upcoming CBLAST-Low pilot study. Jessup will be using a high-resolution infrared camera to remotely acquire sea surface temperature (SST) measurements from the LongEZ. The camera will operate in two separate modes. The first mode will acquire an average SST measurement at a rate of 30 Hz. This measurement is an average of the infrared image composed of 256 by 256 pixels. In the second mode, the entire infrared image is acquired and stored once per second. This high resolution snap shot will help document the SST spatial variability. FRD and the University of Washington will cooperatively work together in an attempt to quantitatively link SST features to the sensible heat flux.

The Everest Interscience infrared temperature sensor used in past air-sea field studies is being outfitted with temperature control circuitry. This is being done to remove a rather nasty temperature dependency that the Everest has. Testing has just began on the sensor performance by keeping the sensor body constant.

Mounts for the remote sensor instrument pod are being reworked for the addition of a fourth laser altimeter. This laser will be oriented at 15° from the vertical and will be used to quantify the roughness of the sea surface under light-wind conditions. (Jerry.Crescenti@noaa.gov, Jeff French, and Tim Crawford).

VTMX

Review of all sample data for the VTMX study has been completed. The review consisted of a full secondary verification process, manual inspection of the data and examination of time plots. All quality control data are now being scrutinized to provide information about the precision and accuracy of the Automated Trace Gas Analysis Systems (ATGAS) and the sampling method. The full report will be available by the stated goal of May 2001. (Debbie Lacroix, Roger Carter)

Model Validation Program (MVP)

Further progress has been made in unscrambling the LongEZ data collected during the MVP session at Vandenberg Air Force base. A study of the coherence and phase relationships among several data channels revealed that the analog (*e.g.*, temperature, accelerometers) channels and GPS attitude angles are usually synchronized in time. The GPS positions and velocities, however, are normally shifted five seconds from the rest of the data. Since the onboard data acquisition system used the time tags from the GPS positions and velocities to archive all the data channels, the times stored in the raw data files are accurate for the positions and velocities but are five seconds off for the rest of the data channels. (Richard.Eckman@noaa.gov)

Cooperative Research with INEEL

INEEL Emergency Operations Center (EOC) Support

A drill was conducted on April 19 to simulate a terrorist infiltration of the Power Burst Facility (PBF). NOAA personnel provided support to the INEEL planning bridge to forecast the location of a possible plume resulting from terrorist explosions at this facility. (Jerry.Crescenti@noaa.gov, Roger Carter)

INEEL Mesoscale Meteorological Network

We have received a request from DOE to provide cost estimates for a lightning detection system on the INEEL. There is considerable interest in being able to track lightning strikes on the INEEL during the peak range fire season which starts about 1 July, but the available budget is limited. We are looking into a number of possibilities including a network of low cost lightning sensors. (Roger.Carter@noaa.gov)

For the past several years, FRD has been collecting data from Pressurized Ionization Chambers (PIC) that are co-located with the meteorological towers of the INEEL Mesoscale Meteorological Network. The PICs measure direct gamma radiation. Some are owned by the State of Idaho and some are owned by the INEEL. Due to a personnel change at the INEEL, we were unable to deliver the PIC data from the INEEL owned PICs to the Environmental Monitoring group for the past several months. We have now set up a new point of contact and automatic delivery of monthly data sets will begin again on May 5, 2001. (Roger.Carter@noaa.gov)

INEEL Wildfire Support

Due to the lower than normal snow pack, the fire season this year is expected to again be quite active. The various organizations associated with INEEL are preparing for the upcoming season. One issue affecting FRD is the use of the high-volume radiation samplers collocated with the FRD Mesonet towers. Some of these samplers were activated during one of the wildfires last year. The problem is that these samplers are intended for use during a major reactor accident at INEEL. There is currently interest from the DOE in using the samplers more routinely for environmental monitoring during wildfires, when the expected radiation levels are close to background levels. This would be a significant change in mission for the samplers. More stringent quality-control procedures on both the samplers themselves and on the air filters would be required to successfully monitor radiation at such low levels. These procedures could be quite expensive, and they are currently not budgeted into FRD's support to INEEL. (Richard.Eckman@noaa.gov)

INEEL Meteorological Support

As reported in last month's activity report, seismic alarms at INEEL were accidentally set off on 22 March by personnel using plastic explosive at the site. FRD was asked to study the meteorology on this day and the previous day, when explosive had been used without incident. The FRD investigation was completed by the second week in April, and a written report was delivered to INEEL. The report was primarily based on observations from FRD's radar wind profiler and RASS system, together with MM5 mesoscale model simulations using a fine-resolution nested grid with 3 km horizontal spacing. The MM5 runs actually did quite well in simulating the wind profile. Figure 4, for example, compares the simulated and observed winds at 1500 MST on 21 March. MM5 usually had a negative bias in its temperature predictions, although the model's boundary-layer depths were quite similar to the observed depths. (Richard.Eckman@noaa.gov)

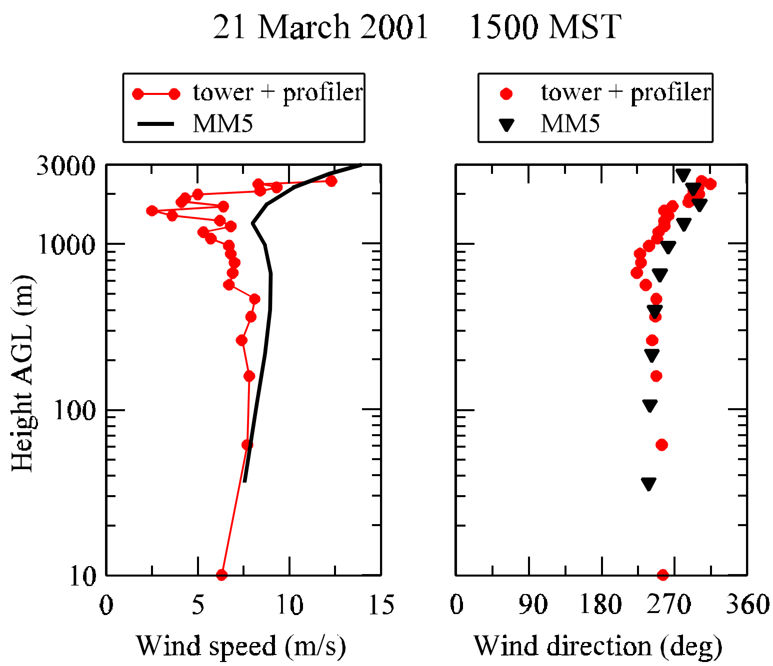

Figure 4. INEEL wind profile from MM5 compared with observations. The bottom two observations are from a tower, whereas the others are from a radar wind profiler.

Other Activities

ARL Review

Over the last month, many FRD personnel have been involved with preparations with the upcoming ARL review that will be held on May 9-10 in Research Triangle Park. Tim Crawford will give an oral presentation on FRD activities while Jerry Crescenti will give an oral presentation on air-sea interaction research programs. In addition, Tim and Jerry will present two posters entitled "Applying ARL Technology to Solving Air-Sea Interaction Research Problems" and "Tracer Gas Technology: Providing Ground Truth for Dispersion and Air Quality Monitoring." An emphasis has been placed both on the oral presentations and posters how the FRD activities are intimately involved with the four ARL themes (Weather and Air Quality, Coastal, Climate, and Technology Development and Transfer). Several pieces of technology will also be presented to the peer review panel and NOAA management. (Tim.Crawford@noaa.gov, Jerry Crescenti, and staff)

Proposals

ARL has submitted a proposal in response to a request issued by the Joint Fire Science Program, which is a partnership of six federal agencies. The proposal is titled "Forecast of Smoke Dispersion and Air Quality in Near Real Time Using NASA Terra and Aqua Satellite Data," and it is a cooperative effort with the Forest Service's Fire Sciences Laboratory in Missoula, MT. The proposed objective is to forecast regional smoke dispersion using the ARL READY system together with emissions models developed by the Missoula group. FRD's contribution would be to provide high-resolution transport modeling using MM5. Currently, the READY system's coverage in the western U.S. is based on the standard NCEP model products, which have insufficient resolution for regional smoke dispersion. (Richard.Eckman@noaa.gov, Bruce Hicks, ARL HQ)

Papers

Mahrt, L., D. Vickers, J. Sun, T. L. Crawford, G. H. Crescenti, and P. Frederickson, 2001: Surface stress in offshore flow and quasi-frictional decoupling. *Journal of Geophysical Research*, *accepted*.

Vandemark, D., P. D. Mourad, S. A. Bailey, T. L. Crawford, C. A. Vogel, J. Sun, and B. Chapron, 2001: Measured changes in ocean surface roughness due to atmospheric boundary layer rolls. *Journal of Geophysical Research*, **106**, 4639-4654.

Travel

Kirk Clawson, April 2 - 27, to Dugway Proving Ground, Utah, to participate in the AFTAC (Gauntlet) Project.

Brad Reese, Shane Beard, Bill Behymer, David George, Mark Hoover, and Dianne Hoover, April 3 - 27, to Dugway Proving Ground, Utah, to participate in the AFTAC (Gauntlet) Project.

Eric Egan, April 3 - 19, to Dugway Proving Ground, Utah to participate in the AFTAC (Gauntlet) Project.

Randy Johnson, April 3 - 6, to Dugway Proving Ground, Utah, for set up and preparation for the AFTAC (Gauntlet) Project.

L. Wayne Hooker, April 19 - 26, to Dugway Proving Ground, Utah, to participate in the AFTAC (Gauntlet) Project.